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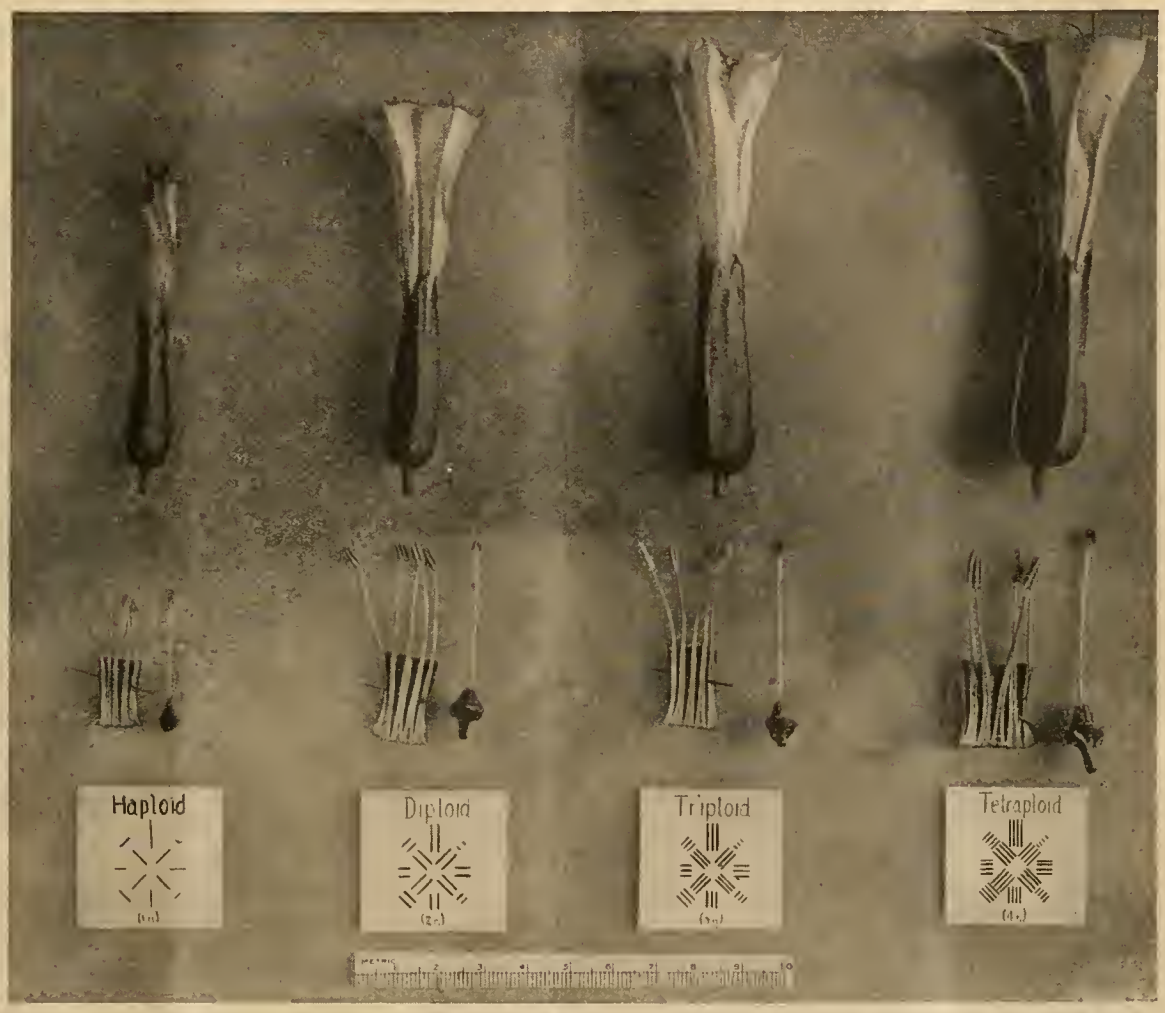

Courtesy, Carnegie Institution of Washington, Station for Experimental Evolution.

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To Develop the Open Mind

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EVOLUTION'S EDITORIAL FAMILY is growing. The Scientific Advisory Board is strengthened by the addition of Dr. Alexander Goldenweiser, Professor of Anthropology at the University of Wisconsin, and Dr. Clyde Fisher, Curator of the Hayden Planetarium at the American Museum of Natural History.

To the group of Contributing Editors we welcome:—Melville P. Cummin, Artist and Naturalist, associated with the American Kennel Gazette; Mrs. Miriam DeFord Shipley, for many years active with Maynard Shipley in championing the cause of Science Freedom through the Science League of America; and Dr. Nathan S. Washton, Director of Biological Sciences, Kittatiny Camp, Layton, N. J., and Merit Badge Counselor in Nature Study, Boy Scouts of America, who will conduct a special Nature Study column for youngsters.

Some Very Fancy Pussyfooting

LAST summer a discharged school teacher, Laura Morris, on trial before the school board at Waynesburg, Pa., was reported to have defended herself against the accusation that she had "taught that man is descended from monkeys" with the statement that she had done no such thing, but had "merely mentioned it as a joke"!

In connection with this case the Philadelphia Bulletin interviewed some of the leading school dignitaries of that metropolis and reports (August 13, 1937):—

> **No Monkey Theories Taught Here**
>
> Both Dr. Edward E. Wildman, director of science education in the Philadelphia Public Schools, and Dr. John L. Haney, Principal of Central High School, join in denying that "the theory that man is descended from a monkey" is taught here.
>
> "The old theory of evolutionists as to whether man is descended from the monkey has been over these many years," said Dr. Haney. "Such teaching is discredited and is not representative of science and so will not be found in our text books."

Observe the fancy foot work of the eminent Drs. in escaping from a tight corner. A straightforward answer would have made difficulties, either with scientists or with the fundamentalists in Philadelphia. So, hoping to remain in the good graces of both camps, they speak with a double tongue and make a statement that can be interpreted in two ways. The scientist can say: "Technically correct. Man is not descended from any existing monkey. Man and monkey are descended from a common ancestor." But Dr. Haney knows the fundamentalists will not make this fine distinction. They will approve Dr. Haney's statement, understanding him to mean that man and monkey are not related at all and that the fact of evolution itself is discredited. Dr. Haney would have a hard time finding a single trained biologist in the Philadelphia High Schools or at the University of Pennsylvania to support such a position. It would make him a laughing stock in the scientific world. On the other hand, to admit that evolution is accepted universally in the world of science, and that it is taken for granted in all serious biology teaching in High Schools and Universities, would bring the fundamentalists down upon him. So he pussyfoots.

He is by no means an isolated phenomenon. We merely mention him since he permitted himself to be quoted. His attitude is quite general among school officials. Under present conditions the teacher of intellectual integrity who refuses to make statements with double meanings, who gives an unequivocal answer to questions, usually remains a class room teacher or is "weeded out" long before reaching the higher executive positions in the schools. We know a few brilliant exceptions, and to them all honor, but jesuitism seems a characteristic fitting for survival as school official in a world half scientific, half fundamentalist.

The remedy? Spread science among the people, until they learn to appreciate the uncompromising honesty of the research scientist and demand the same high standard of the officials entrusted with the education of our youth.

● *L .E. K.*

"The biologist knows that he is temporary custodian of riches of an amazing personal kind—riches that multiply with the sharing—and that for the good of man and of nations these riches must be shared more effectively."

● *—Oscar Riddle.*

An Invitation to Biology Teachers

A Committee of the American Association of Biological Societies has recommended and offered to aid in the formation of a national association of those who teach biology in secondary schools. It is a deplorable fact that at present the 20,000 high school biology teachers are a scattered host, unable even to make contact with each other and powerless to cope with the problems that confront them as teachers of life science. Every high school biology teacher that would like to help remedy this situation and aid in the preliminary work of forming a National Association of Biology Teachers is invited to communicate at once with Dr. Oscar Riddle, Chairman, Committee on Teaching of Biology, The Union of American Biological Societies. Address: Carnegie Institution, Station for Experimental Evolution, Cold Spring Harbor, N. Y.

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Prehistoric Life In California

By CHARLES L. CAMP

Director of the Museum of Paleontology, University of California

IMAGINE, if you will, a telescope so constructed as to allow a peep back millions of years into the past. What would you not give to look through such an instrument—to study the progress of human history through the ages as though you were looking at a three dimensional moving picture—or to witness the procession of animal life during the immense period before the development of man?

Such an experience may never be realized but one can nevertheless examine the past by studying the fossils which are found in the earth's crust. Fossils are the remains, sometimes petrified, of the life of ages long gone by—before man appeared as a civilized being.

The most common fossils are shells and bones of animals, and leaves and stems of plants. We also find tracks, borings, casts and other products of plant and animal life such as natural gas, coal and oil—fossil substances of the utmost importance as reservoirs of power, handed down as a heritage from the distant past, and of fundamental necessity in our present stage of mechanized civilization.

A glance at the fossil record shows that life has existed on this earth for hundreds of millions of years—a prodigious time in which the whole course of written history is the mere flicker of an eyelash. The record also shows that nearly all forms of life have been changing or evolving in habits, body-form, activity, mentality and emotional make-up. Little weak forms become great strong animals in the course of evolution and the great strong creatures exist royally for a while and suddenly disappear leaving other little ones to grow up and take their places. The elephant is descended from a little rabbit-like creature—the giant dinosaurs evolved from small reptiles about the size of a rooster.

It appears evident that man himself has not existed long on this earth. His remains are found only in about the last one thousandth part of the fossil record. He has evidently been here for not much longer than a million years and only in the last one-hundredth part of that time—only in the last 10,000 years at most—has he discovered the methods of organizing himself into what we call civilized society. His conquests over the animals of his neighborhood were made by superior intelligence. He learned how to kill some and tame others. He changed wolves that killed his sheep into dogs that guarded them, unruly buffalo-like cattle into placid milk-cows. He learned how to ride and harness the fiery wild-horse, the temperamental reindeer and the nimble South American camel or llama. He made over the fierce, active wild boar into a fat, lazy tank of lard and bacon. He captured wild sheep in the mountains of Asia and caused them to produce more wool, mutton and less brains. He subdued the elephant and turned him into a live tractor, but he has never really changed the elephant because he has not induced him to breed in captivity. Man has therefore changed his animals by selecting those which he desired, breeding from them and killing or neglecting the others. Nature has doubtless worked in much the same way in the course of ages—eliminating the unfit and preserving the advancing types. We cannot be sure of the method but we can be sure of the fact that most of the animals of the past, including man, have been changing or evolving from one stage to another in the long course of time. Here is a little of the evidence at our very doors.

Fossils of ancient life are abundant in North America and particularly so in California. In fact we know more about the world of life in California just before the coming of man than anywhere else. This record has been preserved in the asphalt pits of Rancho La Brea in Los Angeles, in the caves of Shasta, and in many other natural burial places.

One hundred thousand years ago California was a wild and savage land. The forests found today in the region of Monterey extended southward along the coast. The southland received more rainfall than at present and the grass grew higher. In this grass-land one might have

Painted by Charles R. Knight *Copyrighted by the American Museum of Natural History*

RANCHO LA BREA — CALIFORNIA LONG AGO

seen herds of horses, not very different from the present wild horses of Asia, snorting stallions guarding their seraglios of mares. Crouching in wait for the colts and strays lay great lions, larger than those of Africa. Bands of huge-headed, uncouth wolves roamed through the country following herds of bison similar to those found on the plains in the frontier days.

In the thickets herds of elephants of mammoth size rested during the heat of the day and with them foraged clumsy coarse-haired beasts of slow movement and still slower wit—beasts with huge claws on the front feet which they doubled under them as they lumbered along —these were the ground sloths, related distantly to the smaller tree-sloths and ant-eaters of South America today. Stalking through the cypress thickets were solitary, tiger-like cats with huge teeth, like swords, in the fronts of their mouths. They killed and ate the sloths and smaller elephants — pouncing upon them with great force and driving their terrible sabre-like teeth through the thick hides—ripping gashes and cutting across exposed vessels. The remains of the carcasses were gnawed by the wolves and plucked to bits by the giant vultures—much larger than the California Condor. Ungainly camels, droves of grunting peccaries, an occasional blundering tapir, huge bears, delicate antelopes and deer, mountain lions, coyotes, gophers, bob-cats, badgers, skunks, birds, toads, turtles and all the lesser fry of the present day completed this picture of wilderness life as it was lived one hundred thousand years ago in the valleys of California.

Two Million Years Ago

Proceed backward two million years or so and note the differences in the life of California at that time. Here again are herds of horses—a little smaller—a little stronger than those of today. The elephants, mostly of the Mastodon group, are shorter-legged, with four tusks instead of two, and with longer lower jaws, long low heads, simple teeth and possibly shorter trunks. The ground sloths are just beginning to straggle in from South America, along with them are curious animals like giant turtles or armadillos with a dome-like crust of bony scales all over the back and tiny little feet, tail and head peeping out from under this big shell—there are the glyptodonts—another South American group that visited us for a time. The camels now include some graceful gazelle-like forms and some with spindling legs and necks like a giraffe.

There are plenty of rhinoceroses and these become extinct in North America after this time. The bison have not yet appeared—they will come in later from Asia. The wolves look and act like hyenas with bone crunching teeth and short thick jaws. There are no giant sabre-toothed cats or lions in the Pliocene—their place is taken by a smaller kind of sabre-toothed cat about the size of our mountain lion and bearing more delicate sabres than the Pleistocene form. The antelopes are the predecessors of our plain antelope. There are curious little deer with flattened antlers in this California of two million years ago.

Thirty to forty million years ago the animals of California were still more different from their successors of today. At this time we find but meagre faunas which must be compared with the well known fossils of the plains and rockies to make them understandable. The horses were about the size of sheep, with three toes on each foot, and with teeth fitted only for browsing, not for chewing hard grasses. The rhinoceroses were more like the horses than any rhinos of today. Some of them were rapid runners, some were stodgy marsh living types. The dog and cat-like forms were small-brained, less intelligent, slinking, sneaking forms without the highly developed teeth of later kinds. There was a group of giant animals called titanotheres related to the horses and rhinos but with a double forked horn rising from the end of the nose. These powerful creatures, in bulk much larger than the present rhinos and apparently well able to take care of themselves, became suddenly extinct for some unknown reason. There were giant lump-jawed pigs and curious big-jowled creodonts, (primitive browsing animals, piglike in habits, and distantly related to the pigs and deer). The elephants had simple teeth, long jaws, minute tusks and probably very short trunks—they were much smaller than the modern elephants.

When Waters Covered the Land

During most of the period before the last forty million years the parts of California west of the present Sierra Nevada were covered by the sea. In this ocean lived in very early times, reptiles related to the lizards and crocodiles, fishlike in form with fins and flippers, never coming out on land, even to bear their young.

These big animals also perished—as the whales are destined to do, perhaps in the near future, under the inroads of man.

While the great fish-lizards churned through the seas and the flying bat-like reptiles soared above, the land was inhabited by a strange host of creeping, ambling and rapid running cold-blooded animals of which the dinosaurs were the most conspicuous. At this time the most obscure forms were tiny little warm-blooded hairy mammals related to our opossums, moles and shrews.

The close of the age of reptiles witnessed the destruction of a world of life that had been slowly built up during some 300 million years and was the signal for the development of the modern types of birds and mammals that live about us today. Some of these in turn are rapidly passing out of the picture. The grizzly bear is now extinct in California, the giant condor is nearly so, as well as the California grey whale, and the Roosevelt elk. Even in Africa the great herds are vanishing before the onslaught of the frontiersman—just as the bison did in America. The world is due for constant changes. Change is the order of the day but man should have some control over his destiny if he will but use the intelligence which he may bring to bear upon the complex problems of his social scheme.

●

A PEEP AHEAD

The next issue of EVOLUTION will bring you "The Evolution of The Dog" by Leon F. Whitney; "The Dynamic View of Nature" by Alexander Goldenweiser; "Darwin and Evolution" by Wyman R. Green; "The X-Ray and Evolution" by C. P. Haskins; and other articles dealing with current discoveries regarding the *process* of evolution.

●

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And if you have any items that you think would interest other readers, please submit them for publication.

Fossil Plants and Evolution

By WM. C. DARRAH
Research Curator of Paleobotany, Botanical Museum, Harvard University

FEW fossil discoveries have done more to complete our knowledge of the continuous evolution of the plant kingdom than the discovery of the simplest and oldest land plants.

Almost eighty years ago—in 1859—Sir William Dawson discovered an extremely simple-looking plant in the Devonian rocks of Gaspé. This plant, to which he gave the name *Psilophyton,* had little more than the bare essentials for existence on land. The shoot, scarcely a foot in height, had a bit of underground stem without roots and a series of forking branches without leaves, which bore small terminal spore cases crowded with small spores.

For more than fifty years Dawson's plant was considered to be the inaccurate restoration of an imaginative paleontologist, without scientific interest or value.

During the closing years of the World War two British paleobotanists, Robert Kidston and William Lang, began a series of investigations on the Rhynie Chert, which occurs in Aberdeenshire, Scotland. The Rhynie Chert is a flint-like rock formed by the accumulation of silica from silica-bearing ground water. Fortunately the silica accumulated in a peatbed crowded with the successive generations of small plants which lived in the swamp more than 300 million years ago.

It so happened that the silica in solution acted as a preservative against decay, and, as a result, not only fossilized the plant debris but also preserved the microscopical cells and tissues of the organisms. The life history of these early Devonian plants is therefore known in great detail and with amazing completeness.

The Earliest Land Plant
Psilophyton
Reconstructed by Dawson

Immediately it was recognized that *Rhynia,* the most abundant of these Scotch plants, was a close relative of Dawson's *Psilophyton* which had been disregarded for half a century.

Botanists enthusiastically received the results of these investigations on early Devonian plants. Their salient features are essential to understanding the evolution of all higher plant groups. These small plants are grouped together into one "order" technically termed the *Psilophytales.* They not only have the extremely simple external appearance of *Psilophyton* as described by Dawson, but are accompanied by an equally simple and undifferentiated internal organization. The stem is supported by a slender central cylinder of wood.

The epidermis of the stem contains many breathing organs or stomata showing that the plant was able to live on dry land and manufacture its own food, despite the fact that it bore no leaves which, in more evolved plants, normally carry on food production. This group of ancient plants had acquired little more than the bare necessities of a land existence, eating to live and living to reproduce their kind. There were no embellishments.

It is not quite accurate to speak of these plants as the earliest plants although they are almost as simple as botanists can conceive. Within the past two years, very similar but still more ancient plants have been discovered in the Silurian rocks of Victoria, Australia.

Through these remarkable discoveries we can study the anatomy and reproductive structures of long-extinct plants in detail.

All of the older Devonian plants reproduced by spores — small single-celled structures capable of being distributed in wind or water and living independently of the parent plant for long periods of time. Spores are so resistent to decay and destruction that they are familiar fossils, despite their minute (usually microscopic) size. For example, a Devonian plant named *Sporocarpon* from the vicinity of Delaware, Ohio, is known in its late embryological stages. In figure two, the photomicrograph shows a cluster of four spores, or tetrad, which have grown from a spore-mother cell. These spores are 280 million years old.

Spores are sometimes so abundant and accumulate in such great quantities that they form entire coal beds. So-called cannel coals and many oil-shales are largely composed of isolated spores.

These simple ancestral spore-bearing plants gave rise to greater and more diversified plants. Then development of wood soon made increased size possible. The great Carboniferous spore-bearers, such as *Lepidodendron,* attained an over-all height of 100 feet even with the obstacle of a scant supply of wood. In these trees, the progenitors of our existing lowly ground pine, the fleshy cortex was so thick that German botanists have named them "rindenbaume" or rind-trees.

Nevertheless, spore-bearers are limited in their potentialities. A large number of spores must be produced so that the successful germination of a few is assured. This is wasteful and new races of plants gradually produced fewer spores of two kinds, male and female, which were supplied with mechanisms for survival during unfavorable periods. The culmination of this trend was the evolution of the pollen (male) and the ovule (female). The fertilized ovule grows into the familiar seed.

One of great gaps in the story of plant evolution at the turn of the twentieth century was the transition from the higher spore-bearing plants, such as the ferns, to the lower seed-plants, in cycads and conifers, our cone-bearing trees.

Spores of Sporocarpon
280 millions years old
magnified 100 times

Codonotheca
a pollen bearing organ
from Illinois

Two Seeds of a Seed Fern
A Nodule from the Carboniferous
200 millions years old

The final discovery of the "missing-link" in 1903 verified a prediction made fully twenty years earlier. The discovery of true seeds in actual connection with fern-like foliage fulfilled the requirements for a perfect missing-link. In 1883 the Austrian paleobotanist Stur noted that among the abundant remains of fossil ferns of Carboniferous age, there were many kinds for which no examples of fruiting specimens had ever been observed. Surely these were not ferns—even the more negative evidence of the absence of fruiting examples needed consideration. For a time Stur's question went unanswered, although in 1899 certain petrified stems were recognized as having anatomical relationships with both ferns and cycads. Upon these stems was bestowed the name *Cycadofilices,* or cycad-ferns. The paleobotanist was getting close to an answer, but not yet was he justified at anticipating a conclusion.

It remained for Kidston and Scott in England and the late David White in America to discover actual remains of seed-bearing ferns which were immediately classed in a new group—the *Pteridosperms,* or seed-ferns. We are now supplied with sufficient data to know that the names Pteridosperms and Cycadofilices refer to the same group of plants.

The pollen-bearing and seed-bearing structures of Illinois Carboniferous seed-ferns immediately preceded the flowering plants. Botanists generally consider them the remote ancestral stock of all flowering plants. It is a tremendous gap between the Carboniferous seed-ferns which lived 200 million years ago and the earliest recognized flowering plants of 120 million years ago—plants which lived during the Cretaceous age of dinosaurs. During the intervening 80 million years many profound changes took place with numerous trials and errors toward the attainment of true flowers.

There are several so-called missing-links or transitional types in the evolution of the flower which have as yet escaped the scrutiny of the paleobotanist. Past experience has taught us that much of the evidence is probably housed in collections already preserved in museums but has simply been overlooked.

Only a century ago the study of fossil plants was in its formative stages. Gradually a large number of facts, substantiated by hundreds of important discoveries, has accumulated, until we are in possession of the whole picture of the evolution of land plants. The study of paleobotany itself has evolved from the days when it merely dealt with collections of natural curiosities. Today it has taken its rightful place with the other fields of biological thought.

The upward course of plant evolution is an irrefutable fact and the means by which this progress is measured is nowhere better manifest than in the earliest Devonian Psilophytales and in the seed-ferns.

Is This Where Life Begins?

From United States Department of Agriculture

THE borderland between living organisms and chemical substances is one of the frontiers of science in which exploration is active. In this borderland exist the viruses that cause a wide variety of diseases that affect both plants and animals, including man. Whether a virus lives or is a chemical substance without life is a question that puzzles both chemists and biologists. As exploration proceeds, the answer is coming more and more to depend on a finely drawn definition as to what distinguishes living from non-living substances.

H. H. McKinney, research worker of the U. S. Department of Agriculture, working with the virus of the common mosaic of tobacco, has developed evidence that the virus has a very simple mechanism of inheritance. In the past, scientists have usually regarded inheritance as a distinguishing characteristic of living organisms. In popular thought, reproduction or multiplication of a substance may seem a convincing evidence of "life" but science knows of many strictly chemical and non-living substances that increase in a manner which is strongly suggestive of the reproduction in organisms.

Mr. McKinney has developed evidence that the virus of common mosaic of tobacco mutates, giving rise to new viruses which induce mosaic symptoms quite different from common mosaic. Certain of the many virus characteristics mutate more frequently than others. Some of the new virus forms, or mutants, also mutate or give rise to still other new viruses or sub-mutants. Of the many virus characteristics of the common-mosaic virus some are retained by its mutants and sub-mutants. Some of the char-

acters which are peculiar to certain mutants also tend to persist in subsequent mutants from these.

Mr. McKinney and other investigators have found that certain types of virus mutation are more likely to occur under certain conditions, for example, under the influence of high temperatures.

The virus cannot be identified under the most powerful microscope. It will pass through fine filters and retain its disease producing character. To identify a virus, experimenters are driven to observe its effects on the plants it attacks. The virus multiplies in the plant, but no experimenter has been able to cause it to multiply outside the plant. Some viruses can exist in more than one species of plant, and two viruses causing identical symptoms in one species may be distinguished by differences in the symptoms on another species.

Several investigators have experimented with the crystal-like virus protein. They have been able to dissolve this and cause all the known signs of the disease in tobacco and other suitable plants which were inoculated with the solution. Some workers have considered the crystallization test as proof that the virus has been isolated as a pure chemical substance. However, this test alone is not accepted as positive proof because there is still a possibility that the virus may be present as an impurity.

Although Mr. McKinney considers that the "virus and its mutants doubtless reflect a series of closely related compounds which function essentially as genes," he takes the position that this conclusion is still consistent with the idea—held by some investigators—that the virus represents a complex protein molecule. Some investigators consider the genes of plants and animals to be proteins. The virus particles may represent free parasitic genes of a primitive type, but nevertheless similar to the genes which occur normally in plants and animals.

The Glacial Period

By J. HARLEN BRETZ
Professor of Geology, University of Chicago

KINDLY visualize a brick. Chicago is built almost entirely of such bricks. It is also one of the greatest brick producers. Brick is made from clay. Chicago bricks from Chicago clay. That's easy to understand. But how was the clay made? Someone answers "Why, the clay was here in the first place."

Chicago uses vast quantities of crushed rock in concrete work. The rock is limestone, blasted out of immense quarries in and adjacent to the city. These quarries are located where the limestone is close to the surface. In most places it is buried beneath 50 to 100 or more feet of the clay. Now if the clay was here in the first place, the limestone either was put under it afterward (which is absurd), or was made before "the first place" (which is equally absurd). The limestone is beneath the clay and therefore is surely older than the clay. What you meant by "the first place" was "before Chicago was started."

Chicago uses vast quantities of sand in its building operations and in raising its railroad grades above street grades. Most of this sand comes from the dunes in northern Indiana, along the shore of Lake Michigan. "Where did the dunes get it?" That's easier to answer than "where did the clay come from." Any visitor at the Dunes sees almost at a glance that the dune sand is simply the beach sand, swept up from the shore of the lake by the wind.

The brick clay, the limestone and the dune sand all were here before Chicago's history began. Only the dune sand is still accumulating, and its method of origin therefore perfectly clear. How was the clay made?

If it were necessary to witness the events of the history of the earth to know of their occurrence, we would know precious little about the subject. The old earth has been a long, long, long time in the making, and Man as an intelligent observer has been writing records on stone, parchment and paper for only a few thousands of years.

But, happily, the processes by which the Earth has been brought to its present condition have left indelible, unmistakable records of their own. Graven on stone, too, but the hieroglyphs are wholly different from any that men ever designed. When we learn to read them, we can answer that question "How was the Chicago clay made?" Let's have a look at that clay.

We are standing now on the brink of one of the big Chicago pits. The steam shovels have dug deeply to the bed-rock, the limestone. Look at the surface of that limestone from which the clay has been removed. It is as smooth as a floor. And look at those parallel grooves and furrows across it, all directed northeast-southwest. Looks as though some great planing machine has been run across it. If we go down into the pit and scrutinize the surface of the limestone more carefully, we find millions of tiny scratches, as fine as though made with the point of a needle, and all parallel to the course of the grooves and furrows. Whatever made the surface of the limestone smooth, whatever made those grooves and furrows and tiny scratches—moved across the bedrock surface either from the northeast or from the southwest.

A Giant Planing Machine

While we are down in the pit, let's look at the clay more carefully. It isn't all clay! It has many stones in it, some three or four feet in diameter. And they have the same sort of markings on them as the bedrock! Except that they point in various directions on the same boulder.

We may assume that whatever made the markings on the surface of the bedrock, also made the markings on the stones in the clay. Then the clay which contains the boulders and which lies on the scored surface of the limestone, was made at the time the markings were made. And isn't it perfectly logical to think that the scratched boulders and stones were the tools used by our hypothetical planing machine in smoothing, grooving and scratching the surface of the underlying limestone?

Here's another significant thing. Many of these stones are not of limestone. Here's one of granite! Another of sandstone! A third one of quartzite! Here's another granite, different from the first! We shortly identify twenty or more different kinds of rock, none of them limestones. Now *where* did they come from? There's no granite under Chicago for half a mile down, as several deep wells in town tell us. Therefore the boulders of

foreign rock must have been brought here in some way from some place which has a granite bedrock.

Now, what's the next step in our reasoning? You will probably beat me to the idea before I can announce it. If the granite and other foreign rock fragments were brought to the Chicago region, and if in the bringing, they were scratched and the bedrock limestone here was scratched and fluted in a northeast-southwest direction, then the granite, etc., came from the northeast or the southwest. That it came from the northeast is clear when we find that there are fragments here from the outcropping bedrock north of Lake Superior and Lake Huron. Even pieces of the native copper of the Lake Superior copper country are found now and then.

The Clay Was Left by Glaciers

But what brought the foreign boulders and stones from the northeast? What forced them to gouge and plane and smooth the underlying limestone? What ground up the softer material to make the clay? The geological agencies which shift materials about on the earth's surface, and which wear the material in transit, are waves, streams, wind and glaciers. Waves never move, or deposit, such heterogeneous material as clay and stones together, and they never mark the bedrock in the fashion we saw in the clay pit. Streams are likewise guiltless. Wind never did anything of this sort, though, admittedly, the wind does blow sometimes in Chicago. But the glaciers of our western mountains and of Alaska and of Greenland and of Antarctica make precisely similar deposits and mark their debris and the bedrock over which they move, in precisely the same manner.

So here at last we reach a conclusion that seems perfectly logical and in perfect accord with the facts. We have used the scientific inductive method in solving the problem. We have no alternative explanation except that "the clay was here in the first place"—and that's no *explanation*.

Now that we have proved that the Chicago region has been covered by an ice sheet, you may lay down that brick! We are going farther afield. We scout about Wisconsin, Illinois, Indiana, Michigan and adjacent states. Everywhere we find the same typical glacial record. Wait! We fail to find it in southern Illinois, southern Missouri, southern Indiana. We soon find that we can draw a line across the United States, from east to west, north of which is the record of glaciation, and south of which none of this record can be found. The ice-sheet spread from the northern part of the continent down into New Jersey, Pennsylvania, Ohio, in one place about 20 miles over into Kentucky, Indiana, Illinois as far south as Carbondale, Missouri, northeastern Kansas, eastern Nebraska and eastern South Dakota, most of North Dakota, northern Montana, Idaho and Washington. All Canadian territory was under the great ice-sheet. Indeed, the ice-sheet was a Canadian product for it centered near Hudson Bay and spread out in all directions. Yes, it actually moved northward from the continent toward the Arctic Sea.

The Far Flung Front of the Ice Sheet

The Ice Sheet Made Our Lakes

The influence of that ice-sheet today is manifold. Almost all of the hills and valleys of the northern states which I have named are the result of that glacial experience. Rarely do we find a region where the bed rock makes up the hills. Most of them were built up by the deposits made by the ice. The ice was a gigantic rasp, thousands of feet thick, armed below with fragments of rock picked up in its course, and this wreaked havoc with the pre-existing hills and valleys of the invaded region. Then, when the ice melted (for that is the only way it could be removed) all the detritus worn and torn off the underlying rock from Labrador southward, was left behind, resting on the planed and smoothed and scratched bed rock floor. (We're back to the clay pit, again, you see.)

The old river valleys in many places were completely filled and the streams had to find new courses. Niagara River is the most spectacular case of this sort. The new course just happened to cross a cliff of limestone and the Falls of Niagara resulted.

The multitude of lakes of northern Michigan, northern Wisconsin and northern Minnesota all owe their existence to the irregular deposition of the glacial debris. How many of the honeymooners at Niagara and how many of the fishermen in the lake country appreciate this? Oh, well—you can't blame them! Love and fish are matters of vital moment—glaciers are not.

Almost all the soils of the northern states are due to the glaciation. The glacial deposits have been worked over somewhat at the surface, rain has percolated thru and dissolved some substances, organic matter has been added from the prairie sod or the forest duff; otherwise we are farming on the ground-up debris left by the ancient ice sheet which covered nearly half of North America.

Most interesting, perhaps, is the fact that our Great Lakes owe their existence to the glaciation. Before the ice invaded from the north, these lake basins were simply broad river valleys. The ice sheet was thousands of feet thick, its surface, if like that of the Greenland and Antarctic ice sheets of today, was fairly level, but its bottom fitted down to the major pre-glacial hills and valleys. It therefore was thicker where the valleys were, and there it eroded more. Then, during the waning of the glaciation, it lingered longer in these lower places and built up the southern margins of the basins to make the dams which today withhold the lakes from flowing to the Mississippi. New outlets were found, converging to the St. Lawrence. Niagara, as I have indicated, was one of these post-glacial outlets.

(*To be continued in next issue*)

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In Praise of Natural History

By WILLIAM KING GREGORY

I

OH, LET us give praise unto Natural History;
for she hath revealed the splendor of the heavens, the majesty of celestial power.
Her fields are Space and the Universe of Light:
her dominion stretcheth from everlasting unto everlasting.
The stirrings of the atom are her province: she dwelleth among all things visible and invisible.
The motes dance and the stars of Orion move in harmony;
So shall their music delight her soul.

II

She conjureth the uttermost past: behold the sun travaileth in labor and sorrow; but at last the earth, the moon and the eleven stars spring forth from its side.
When she holdeth up her mirror to man the planets move in their turn;
the moon followeth its appointed round, the morning star foretelleth the rising of the sun.
The earth trembleth and the waters thereof are troubled: the winds blow and the foundations of the great deep are broken up.
Again the sea is calm: its sands drop down in quiet pools; living things come forth on to the land.

III

The chronicles of the ages are hers; the generations of living things are numbered in her book; the records of their origins are graven upon her tablets.
She knoweth how soon they end in labor and sorrow; they go down finally into the grave.
She interpreteth the writings of the ancients: the wisdom of old is hers, and of the future she prophesieth.
By her the living are measured and the dead appraised:
Yea, they that have gone before live in her memorials;
for her labors endure from generation to generation.

IV

All the living creatures of the earth are sought by her:
she hath given them names and made known their place in the world.
To her nothing that is alive is of no value; the labors of the ant are instructive, and the way of the bee worthy of remark.
She sheweth the antiquity of our descent: nevertheless our forebears were akin to foolish apes, and their forebears the smallest of the beasts of the field.

V

Yet are we not utterly without hope: for she hath declared unto us a way of salvation.
She hath shewn us the reason for the sinfulness of man.
The origin of his perversity she hath made plain.
We may perchance correct our faults through her instruction, and her teachings lead to humility and understanding.
So let us give praise unto Natural History;
for nothing on earth is too humble for her to study and the splendor of the heavens is open before her.

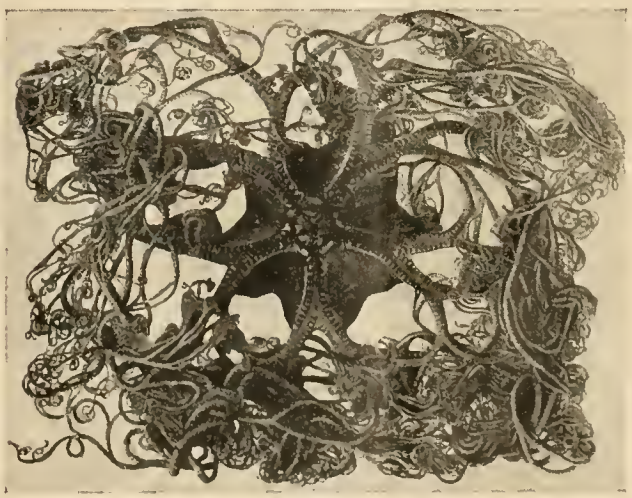
Animals of Land and Sea

By PAULINE H. DEDERER
Professor of Zoology, Connecticut College

IF YOU have ever on a summer's vacation had the pleasure of exploring some rocky pine-girt island along our New England coast, you have probably seen, when the tide receded, many pools left among the rocks, forming natural and beautiful aquaria. In such tide-pools as these you may find in abundance starfishes of various sorts, their cousins the sea urchins encased in round spine-covered shells, tiny snails tightly fastened to the rocks (relatives of the Mediterranean forms whose bodies, when crushed, yield the Tyrian purple dye), sea anemones as big as apples, colored red, brown or orange, and thousands of barnacles, each animal secure within its white tent-like shell.

You will also probably find what you may imagine to be various kinds of seaweeds, which would prove to be beautiful sorts of animal communities termed hydroids, in which each individual, like a many-petaled flower, arises gracefully from a tiny transparent vase. If, however, a small lobster-like animal should dart that way, the waving tentacles would grasp and paralyze it, and finally pull it down into a central mouth, suddenly become capacious. The flower-like organism is plainly an animal, since it has the ability to feel, to move, and to digest food. The seaweeds, on the other hand, which they resemble so closely, show no sign of feeling, do not move voluntarily and are nourished by inorganic substances which they absorb from the water.

There are certain characteristics of living things, whether plants or animals, which mark them off sharply from their inorganic surroundings, the water, rocks or sand. These are: a peculiar chemical constitution, definiteness of organization, the power to repair themselves as their tissues wear



Courtesy American Museum of Natural History
A "Basket" Starfish

out, the ability to grow and multiply, and the ability to adapt themselves to their surroundings. Every living thing in this pool, for example, is composed of six chemical elements, always the same six, with which few or many others may be combined. If we should try to imagine a machine of some sort which could stoke its own engine, oil its own gears, repair a break, and finally reproduce other machines like itself, we should realize how remarkable are the powers

Courtesy American Museum of Natural History
A Hydroid Colony

of repair, of growth and reproduction in living things which we take so much for granted.

Returning to our tide-pool we find many conspicuous examples of the way in which animals are adjusted with such intricate nicety to the conditions of their environment. To succeed in any environment, the animal must be able to secure food and oxygen, to protect itself from enemies or adverse conditions, and to reproduce its kind. Animals of different kinds, even in the same environment, meet these problems in various ways. The rock barnacle lives secure within its shell, the roof of which is tightly closed when the tide recedes. But if you splash the water in the pool, you may see the peak of the roof open, and small feathery processes reach out and wave about in the water to gather in food. The snails which crawl slowly over the rocks will at low tide pull themselves entirely within their shell, which may often be closed completely by a little horny plate, making them secure against attack or drought. Turn a starfish over, and it immediately sends out hundreds of thread-like projections which touch the adjacent rock; the threads shorten, and presto—the animal is right side up. Touch the crown of tentacles of the sea-anemone or try to pull it off the rock; the animal will contract into a slippery ball, and numerous stinging threads like white cotton fibers will protrude from many pores.

One other characteristic of living things remains to be briefly explained, namely definiteness of organization. A plant or animal body can be resolved into elements or microscopic units which are called cells. They are not little hollow cases, as the name implies, but extremely minute units of living matter called protoplasm, with a peculiar central body or nucleus. These cells are of different shapes, being much elongated in muscle and nerve cells, disc-like in blood cells, and spherical in egg cells. The living matter composing a cell appears under the microscope as a tiny mass of granular jelly-like material, containing the spherical nucleus, and surrounded usually by a thin membrane or cell-wall. It was of this fundamental protoplasm that Huxley wrote in his famous essay "The Physical Basis of Life". Many experiments upon cells have been made which demonstrate that the nucleus is essential for the life of the cell, and that certain peculiar bodies called chromosomes, which it contains, are the bearers of the hereditary characteristics from one generation to the next.

The animals that I have mentioned above make their home along the continental shelf, a sort of gently sloping extension of every continent, with relatively shallow water. Here is a region of turbulence, of movements of tide, of dashing surf, of warmth and sunlight and plenty of food. The shore is "noisy with the conjugation of the verb—to eat". Other regions of the sea also have their inhabitants. On the surface are myriads of tiny floating creatures, food for larger animals. Further down are the swimmers, great sharks and other kinds of fishes. Down in the remote depths live many kinds of strange fishes where no sunlight penetrates, where the pressure is enormous and the temperature is near freezing.

All these creatures, from their earliest history, have made the seas their home. But strangely enough, two of the most impressive types that swim the seas, namely the seals and whales, evolved from land animals and are really mammals as their body build shows, with only superficial resemblance to fishes.

Book Reviews

EXPLORING THE HEAVENS. By Clyde Fisher. 223 pp. New York: Thomas Y. Crowell Co. $2.50

Modesty is undoubtedly the reason why Clyde Fisher, Curator of Astronomy at the American Museum of Natural History for many years, responsible for the erection of the Hayden Planetarium and now its Curator, has not long ago published a book on popular astronomy. For a long time he has been in demand for lectures on the subject. For years he has been visiting the observatories throughout the world, four times he has taken part in solar eclipse expeditions. He has studied meteor craters right on the ground here and in Europe, and has helped bring together the finest collection of meteorites in the world. Yet this is his first book on astronomy.

It does not attempt the whole wide range of the subject, but limits itself very largely to the solar system, and to the stars only as the naked eye and the small telescope sees them. In short, it presents the subject much as the Planetarium can present it. Add chapters on the Origin of Our Solar System, and A Glimpse of Relativity, accounts of the great observatories, and of the Hayden Planetarium, rather full details on eclipse experiences and meteor craters, and you have a wholly delightful and clear account of the Earth and Neighbor Worlds, the Sun and Moon, Meteors and Comets, the changing seasons with their pageant of constellations and mythology.

As an introduction to modern astronomy the book is outstanding. It is especially to be commended for its many select and beautiful illustrations,

including this year's solar eclipse, views of the Arizona and Esthonian meteor craters, a model of the mounting for the great new 200 inch reflector, and close-ups of the wonderful Planetarium projector. —*Allan Broms*

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BIOLOGY AND HUMAN BEHAVIOR. By Mark Graubard. 413 pp. New York: Tomorrow, Publishers. $2.50

The specialists on the subject throughout the scientific world are quite in accord that human behavior results from the interaction of that biologic organism, man, with his environment, which admittedly is not only physical, but social as well. Few, however, are both competent and daring enough to employ and apply this modern truism through all its implications. Dr. Graubard is in this sense exceptional; for he is competent as biologist and psychologist; and he does dare to follow through to the social implications of his studies. In fact he begins by calling attention frankly to the existence of both free and enslaved sciences, the latter being those in which free inquiry and teaching are restricted by established prejudices and vested interests. Obviously, these are primarily the economic and social sciences, whose professors must needs walk softly lest they tread on influential toes. For himself, he insists on freedom at any personal cost, and thinks and writes accordingly.

After an excellent introduction on The Method of Science, he devotes three chapters to The Animal and Its Environment, giving a most explicit summary of our knowledge of living matter, neural reactions, conditioned reflexes, functioning of sense organs, dynamic equilibriums and physiologic buffering, in short the essential modern description of the living and reacting organism. Three equally explicit chapters sum up and clarify the intricacies of cell structure and functioning, the physical basis of heredity in chromosome and gene, the nature and origin of mutations, and our resultant clearer understanding of natural selection and the process of evolution.

To this point the book is just another excellent exposition of recognized modern knowledge. But from this point on the book becomes dynamic and significant. "Human Nature" becomes a realistic, living result of inherent capacities shaped by educational conditioning, and reacting to the impacting stimuli of diverse, often changing, environments. "Human behavior" ceases to be a phrase and comes to life; one realizes that the author is talking about things as they are. One understands better why others have failed to attain such realism when the author gives the Freudian Mythology a piece of his scientific mind, chides the Behaviorists for evasion of social realities and puts his critical finger very precisely on the weakness of the Eugenists and their "program". That weakness turns out to be racial, caste or class prejudice, the myth of self-assumed superiority. That myth or bias is implicit in whatever social and economic arrangements may exist, and will persist while privileged castes, economic classes, imperialistic nationalisms and like social inequalities demand defense and sanction from obsequious professors of science. The daring author concludes quite rightly that the full human potentialities for achievement, and more specifically for socially considerate behavior, cannot even be learned, much less realized in fact, until inequalities of economic and related privilege have been removed from the earth.

—*Allan Broms*

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THE ADVANCING FRONT OF SCIENCE. By George W. Gray. 364 pp. New York: Whittlesey House, McGraw-Hill Book Co. $3

Inevitably this up-to-the-minute book-length report of the news of scientific discovery was chosen as the current selection of the Scientific Book Club. Their Review Committee rightly describe it as "a truly thrilling account in simple, revealing language, of contemporary progress all around the expanding horizon of knowledge. No living reporter is better qualified than Gray to present the current news of scientific research in terms that convey the meaning and spirit of the endeavor without indulgence in false emphasis or sensationalism." By thus quoting unstinted praise from a critical committee of authentic scientists, this reviewer hopes to avert the suspicion of extravagance in the flattering opinions he must give of this outstanding book.

Above everything, it attains the first quality of popular scientific writing, complete lucidity. It presents each problem so fully and clearly, yet with only a necessary minimum of historical setting, that the new researches and achievements are revealed in all their theoretical and practical significances. This is therefore no mere reporting of a miscellany of scattered news-facts, but an entirely coherent account of the concerted advances on many fronts of the increasingly interlocking body of knowledge which we call "science". That we conveniently divide it into fields of physics, chemistry, astronomy, geology, biology, psychology, etcetera, no longer hides the underlying fact that the multitude of apparently diverse natural laws which science studies are interrelated basically.

The author is particularly to be congratulated upon an unusual capacity for popularization without distortion of scientific attitude. This appears not only in the absence of sensationalism, but in the presence of true explanation. So many science popularizers succeed only in telling "what it is about", leaving the reader ignorant of the actual (usually technical) explanation itself. But here one gets insight into the reasons for things, with the technicalities rendered into such simple language that one reads on without even the consciousness that these are difficult problems. Of course there are technical problems quite beyond popularization even by the skill of Gray, but there is nowhere that exasperating pretense of explanation of which so many other popularizers are guilty.

The up-to-dateness and authenticity of the book are secured by Gray's method of gathering his news. He has gone directly to some seventy-odd scientific workers in laboratories and observatories, and from them has drawn the story of what is new and important in scientific research.

Necessarily there had to be selection of material, and the only fault one finds is the omission of several fields in which fruitful and vital research has recently been done. As it stands, the book deals largely with physics, chemistry, astronomy, geology, biochemistry and medicine. Archeology, anthropology, psychology and the social sciences have perhaps, in the author's opinion, not made significant advances in recent years. At any rate they have not been included in his story. However, in his concluding chapter, "The Promise of Science", he does drive home the fundamental part that science has and must ever play in solving our problems, physical and mental, technologic and social. Within the limits of nature's law, man, through science, is free to mold his future. In the effective and proper shaping of that future of mankind, he insists on the basic importance of widespread education in science, and (quoting Pavlov) on the "omnipotent scientific method". —*Allan Broms*

The Research Front

Speeding Up Evolution

DISCOVERY of a method of causing evolution was announced at the recent meeting of the National Academy of Sciences by Dr. Albert F. Blakeslee, Director of the Station for Experimental Evolution of the Carnegie Institution of Washington.

For some time it has been known that, among animals and plants alike, parents transmit their traits to their offspring by means of chromosomes, little "threads of life", on which the real heredity bearers, the genes, are located somewhat like tiny beads on a string. A set of these chromosomes is inherited from each parent, carrying a full complement of genes for transmitting all the various characteristics of the parent plant or animal. These merge, and in that merger the characteristics of the offspring are determined. If nothing has happened to change the genes, then "like begets like" and the children will be like their parents.

But we know that heritable variations, or mutations, do occur in nature. The young are not always like the old. A great many instances have been observed where new characteristics have come into being. Such mutations occur when something has happened to the genes, causing them to transmit to posterity a message different from that received from their ancestors. Plant and animal breeders are constantly on the lookout for suitable mutations with which to "breed up" seed and stock.

How to affect the genes and cause mutations artificially and thus speed up evolution is a problem that has challenged the attention of scientists for a long time. In Volume III, Number 1 of EVOLUTION, Dr. H. J. Mueller described a method for bringing this about by means of X-rays. Scientists in many Agricultural Colleges are now experimenting on various plants with this method.

Dr. Blakeslee experimented along a different line. He tried out the effect of various chemicals in his effort to induce hereditary mutations. And he found that a chemical, *colchicine,* would cause mutations in plants, doubling the chromosomes and genes, (distinguished from mutations due to changes within the genes).

He reports: "The alkaloid colchicine we have found will induce an abundant production of branches with doubled chromosome number. When seeds are heavily treated all the seedlings may be affected. Doubling in adult tissue has been induced by immersion of twigs in solutions and in agar, by treatment of buds with mixtures of colchicine and lanolin and by spraying with solutions. By the use of colchicine changes have been induced which are interpreted as being due to doubling of chromosomes in the following genera: Datura, Portulaca, Cosmos, Phlox, Nicotiana, and several others.

"If control of chromosome doubling proves of general application, as seems to be the case, the plant breeder will be able to work with greater precision in his efforts to control the evolution of economic forms of plants propagated vegetatively as well as those produced by seed. Starting with a sterile hybrid, a pure breeding double diploid has been synthesized, having hybrid vigor and the desirable characteristics of tetraploidy. Doubling the chromosome number would give enlarged flowers and fruits to the horticulturist. In addition to increase in the size of the organs of plants, doubling the chromosome number has changed a self sterile to a self fertile form, changed a dioecious to a hermaphroditic race and an annual into a perennial, and has increased winter hardiness. In Zoology the causing of chromosome doubling is an unexplored field, but it will probably be a fertile one. The ability to induce chromosome doubling therefore is of importance to practical as well as theoretical genetics."

(*In an early issue Evolution will bring its readers more details regarding Dr. Blakeslee's epoch making discovery.*)

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The Borderland of Life

TWO reports made at a Symposium on Biophysics, just held at the University of Pennsylvania under the auspices of the American Institute of Physics and the Eldridge Reeves Johnson Foundation for Medical Physics to apply the findings of modern physics to solution of biological problems, will be of special interest to readers of EVOLUTION.

Dr. Wendell M. Stanley of the Rockefeller Institute for Medical Research, who achieved fame two years ago with the successful isolation in crystalline form of the virus that causes tobacco mosaic disease, reported the isolation of two viruses causing disease in animals. Like the virus of the tobacco mosaic disease, these viruses are not small living bacteria, as had been supposed, but giant protein molecules, resembling the ordinary protein molecules of protoplasm but larger, and having the life-like ability of reproducing themselves rapidly when in contact with living matter.

It appears that in these viruses Dr. Stanley has discovered forms that exist in the "twilight zone" between the living and the non-living, having certain properties of each, but belonging to neither. They help to bridge the gap between the organic and the inorganic worlds. They furnish one of the most important "missing links" that fundamentalists have always challenged the evolutionists to find.

The study of these invisible forms, so small that they pass through the finest porcelain filters, but capable of causing many of the most serious diseases in plants and animals, has occupied men of science for many years. But not until Dr. Stanley isolated the tobacco mosaic virus was their nature definitely understood. They are molecules of protein, similar to the protein that exists in all protoplasm, but in a suitable environment they seem to "come alive" and reproduce their kind indefinitely.

"In view of the properties which this protein possesses," says Dr. Stanley, "the borderline between the living and the non-living tends to become non-existent, for although it possesses properties which have been regarded as characteristic of living things, such as specificity of host-range and the ability to reproduce and mutate, it is nevertheless a protein molecule, and as such may be regarded as non-living."

To the evolutionist one of the most interesting features of this protein molecule is that, in common with all forms of life, it is subject to mutation, and therefore to the process of evolution. Such virus mutations have already been observed in nature, and have even been brought about artificially in the laboratory by chemical means. Through mutation a virus growing in connection with one kind of plant becomes adapted to existence on another plant, or capable of producing a different disease from its ancestral virus. This protein molecule seems to be closely akin to the gene, the heredity bearer, through which the traits of living forms are transmitted from generation to generation. It may be that here we have the key with

which to unlock one of the doors to the mystery of life itself.

When Dr. Stanley reported on his work with tobacco mosaic virus about a year ago he expressed the hope that the viruses that cause diseases in animals and man would also yield to the technique he had developed. Success has now crowned this effort.

Other scientists of the Rockefeller Institute, including Dr. Carl Ten Broeck and Dr. Thomas G. Wyckoff, have now isolated the virus that causes equine encephalitis, a horse disease similar to human sleeping sickness, and the virus causing warts on rabbits. Both of these viruses are also giant protein molecules, but they differ enough so that each causes only its own peculiar disease.

It seems probable that certain diseases have their origin in the mutation of some protein molecules from their ordinary harmless forms into forms that are harmful. Again, certain viruses that produce disease in one plant are harmless to other forms of life. Dr. Stanley reports that the virus which causes ring disease in tobacco also exists in the potato, but does no harm, either to the potatoes or to the humans who eat them.

It has also been discovered already that by certain chemical methods these virus proteins can be rendered inactive, but still capable of giving immunity. Thus an entirely new road to the study and conquest of certain diseases opens up.

"The sole objection" says Dr. Stanley, "to the final and complete acceptance of virus proteins as protein molecules is that, although an analogy of a protein reproducing itself in the test tube is known, the self-production of a protein in the living cell is today not an accepted chemical reaction. Immediately we are forced to the inside of a living cell we are faced with a set of conditions that we have not fathomed as yet. The virus protein is apparently imbued with something of which today we are ignorant.

"Knowledge of the mechanism by means of which a given huge molecule-like protein, when introduced in a certain cell, is able to bring about the organization of the amino acids and cellular constituents, with formation of exact duplicates of the introduced entity, is of tremendous importance, for this mechanism is the basis of biological activity.

"The virus proteins, because of their abundance and stability, furnish us with adequate working material for a study of this mechanism."

What Snares Sun-Energy?

EVERY school boy has heard that chlorophyll makes plants green, and that by means of chlorophyll the energy of sunlight turns water and carbondioxide into plant substance, thus creating the primary food upon which all animal and human life depends.

Now comes Dr. Ondess L. Inman, director of the Charles F. Kettering Foundation for the Study of Chlorophyll at Antioch College and tells us that this is not quite correct. No scientist knows as yet exactly what chlorophyll is and just how it does this work of turning inanimate matter into living substance, without which none of us could exist. But in common with a great many other research workers Dr. Inman has been studying this matter, and he has just found out something that no one knew before and that may prove to be of tremendous importance to the future of the human race.

He has discovered that the extracted chlorophyll, which is being studied in the laboratories is not quite the same as the chlorophyll as it exists in the green plant, and that there is another substance within the chlorophyll of living plants that serves as the actual harnesser of the sun's energy. This substance seems to be destroyed in the chemical process of chlorophyll extraction, but he has proved its existence by means of the spectroscope and also by various chemical tests. But he has not yet succeeded in "isolating" it, so that we can not yet be sure about its nature. Dr. Inman says that it appears to have a relation to the chlorophyll similar to that of the protein molecule globin to the hemin in the blood, forming the more complex hemoglobin, and that it probably consists of a protein and a fat.

A high speed ultra-centrifuge will now be used to "isolate" this newly discovered substance from the chlorophyll. This process is a little like that of the common cream-separator, which "isolates" the cream from the milk. This is the same apparatus with which the scientists at the Rockefeller Institute for Medical Research have isolated the tobacco mosaic virus and proved it to consist of extra large protein molecules.

If this experiment is successful it may have far reaching consequences. It may enable us to learn how to do artificially this work done by green plants of storing up the sun's energy, and how to make starches and sugars out of inorganic materials.

The Shasta Daisy

By GARNETT RUSSELL BRIGHT

EXPERIMENTING with the American daisy many years ago, Luther Burbank noticed that one bush had whiter blossoms than any other of the thousands that he had cultivated. With this plant Mr. Burbank began fifteen years of effort to produce a daisy of the purest imaginable white.

First he crossed the American ox-eye with its English cousin by taking pollen from the English daisy and fertilizing the American daisy. Flowers from the seed thus produced were larger and bloomed earlier than either parent, but all had a yellowish tinge instead of the pure white that he wanted.

Next he crossed this hybrid with the German ox-eye, which made only a slight improvement. After five or six years of selecting the best of this hybrid with its three parents he succeeded in raising a much superior daisy, larger and more beautiful in form and just as rugged and prolific, but still lacking the snowy whiteness.

Then he learned of an Asiatic daisy, a coarse plant with an ugly leafy flower, which had the quality he wanted: it was pure white. He obtained seed of this daisy from Japan, brought it into blossom and crossed the pollen with his best hybrid daisy, the product of three parents and many years work. The first season's bloom from these seeds were disappointing, but the second season one plant had flowers as beautifully white as the Japanese daisy, larger than the largest ever brought into blossom. It also had the grace of the American plant and was as vigorous and hardy as any of the four.

Each year for several years he raised thousands of seedlings having these four ancestral strains from three continents, kept the best plants each season and destroyed the others, until at last the wonderful flower known as the Shasta Daisy was produced.

Having succeeded in this, Mr. Burbank proceeded to cultivate slight differences in his various blossoms until now the Shasta Daisy has several strains. The Alaska has larger and more numerous blossoms and longer stems than the original or parent Shasta. Westralia has blossoms of even greater size and very long stems.

It is true that these variations have arisen under artificial conditions; but it is also true that there is nothing in these conditions that may not also occur in nature.

Nature Study Notes

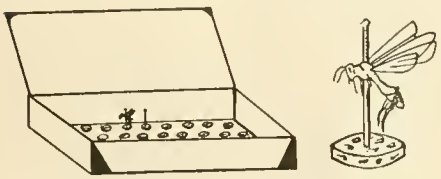
Monthly Feature for Study Groups

By NATHAN S. WASHTON
Merit Badge Counselor, Nature Study, Boy Scouts of America

COLLECTING INSECTS

THE reader should make a collection of insects for study. An economical method for preserving specimens, suitable for the beginner, is as follows: On the bottom of a cigar box or similar box glue some strips of corn-pith, or slices of large cork stoppers, into which pins can easily be stuck.

Pin the collected insects to the cork, leaving the head of the pin sufficiently above the insect to grasp it with the fingers. Be careful not to have the insect too far down on the pin, as its legs would touch the box and break off.



Insects may be killed by immersing them in alcohol for a few minutes. Butterflies and moths may be killed by pressing the body with thumb and forefinger just enough to kill without crushing them. The fumes of benzine or ether will also kill insects.

It is best for several friends to go together in search of specimens, as the activity and success of one will encourage the others. Good places for collecting are the waysides, borders of woods, gardens, fences, lakeshores, brooks, under stones and stumps, the bark of fallen trees, or beneath the layers of dead leaves.

EXAMINING INSECTS

Observe that insects having three pairs of legs have the body divided into three parts, the head, thorax and abdomen, and that with few exceptions they have wings. These are called *True Insects,* or *Hexapods,* meaning "six legs". The ant, fly and wasp have the three parts of the body distinctly separated, but in certain beetles they are so close together that it is difficult to distinguish the dividing line. Examine at least four different types of insects and note the head, thorax and abdomen.

Find the *mouth,* the *eyes* and the *feelers* or *antennae.* The mouth is on the under side of the head. It parts vary greatly in different insects. In those that chew their food, such as beetles and grasshoppers, some of the mouth parts serve as teeth or jaws, and, being joined to the right and left sides of the mouth, move sideways and not up and down as in other animals. In the bugs proper some of the mouth parts are very sharp and slender, forming a long sharp sting to suck the juices of plants. In butterflies they form a long slender tube for sucking the nectar of flowers.

In the common house fly the mouth parts appear as a proboscis, a fleshy appendage which is bent up when not in use. Watch a fly as it feeds. Its proboscis is unbent, and the food is lapped up by it.

In the butterfly and moth, observe the long tongue, looking like a watch spring. It may be uncoiled with a pin. On the front of the head are two feelers or antennae. These are variously jointed, and vary greatly in different insects. In butterflies the antennae are generally long and slender and swollen at the tips, resembling drumsticks. In some moths they are barbed on the sides and look like feathers.

On the sides of the head are round smooth places, the eyes, entirely different from the eyes of other animals. Under the microscope they are seen to be divided into little spaces, like the surface of a honeycomb. Each little space represents an individual eye. Some insects have hundreds or even thousands of these little spaces or eyes, called *compound eyes.* With the microscope you may see three minute dots under these compound eyes. These are called *simple eyes.* In many insects, as in Dragon flies, the compound eyes are very prominent, enabling them to look backwards as well as forwards.

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Darwin and the Beetle

"No pursuit at Cambridge gave me so much pleasure as collecting beetles. It was the mere passion for collecting, for I did not dissect them, and rarely compared their external characters with published descriptions, but got them named anyhow. I will give proof of my zeal: one day, on tearing off some old bark, I saw two rare beetles, and seized one in each hand; then I saw a third and new kind, which I could not bear to lose, so that I popped the one which I held in my right hand into my mouth. Alas! it ejected some intensely acrid fluid, which burned my tongue so that I was forced to spit the beetle out, which was lost, as was the third one."—From Charles Darwin: Autobiography and Letters, Edited by his son, Francis Darwin.

Mosquito Music

SOME time ago under the heading "Mosquito Ignores Darwin" the N. Y. Herald Tribune published without comment the following epistle from one Richard Lester:

> "Last night I was awakened from my slumbers by a familiar jewsharpian sound approaching my right ear. When I felt a hairlike touch on my face I whacked, and another Jersey mosquito bit the dust.
>
> "It occurs to me that the song of the mosquito, far from aiding said species to survive, helps them to reach mosquito heaven sooner. Why is it that in the struggle for mosquito existence the singing variety haven't long ago been selected out as less fit, and silent mosquitoes been left to inherit the earth and me? That's the way things are supposed to happen, according to the best evolutionary doctrines of Charles Darwin. Can it be that the tunes struck up by this tiny creature, as it wings its way earward, disprove Darwin's venerated doctrines?"

Nay, nay, friend Lester, it can NOT be. That buzzing sound seems to be an important feature of the love-life of the mosquito, whereas whether you whack a mosquito more or less is of but little moment to the mosquito species. Dr. C. H. Curran, entomologist of the American Museum of Natural History tells us that the buzzing sound serves to attract the male mosquito. Of all the billions of mosquitoes that buzz, only now and then one is heard and whacked by a human being. Most of them suck juices of plants or animals not so well equipped for mosquito whacking as man.

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The Monkey's Paw

Two men argued evolution;
Its believer nothing said,
But he used good elocution
When he scratched his itching head.

Elmer William Gardnier.

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Fundamentalist Follies

CLERICAL EMBRYOLOGY

By E. T. BREWSTER

IT'S old stuff; but it turns up again, quoted by the *Bible (Ex)-Champion,* that is now a portion of *Christian Faith and Life* (*Apr.* 1931, p. 182).

"There are radical differences between the embryos of vertebrates and invertebrates. Worms and other articulates in embryo lie doubled backward around the yolk, while all vertebrates are doubled in the opposite direction. According to the theory that the embryonic condition is a recapitulation of the stages of organic evolution, this fundamental fact of invertebrate embryology ought to have been preserved by the vertebrate. Evolution gives no account of this reversal of position by the vertebrate."

Of course, it is not true that "all vertebrates are doubled in the opposite direction"—as any bright undergraduate who has begun embryology could have told the two Doctors of Divinity who are perpetrating this particular piece of Fundamentalist nonsense. The most important branch of the vertebrates for us, namely the higher mammals, have almost no yolk to their eggs and so can't double round it either way.

Neither do most "invertebrates." The fact is, what our D.D.'s, following the zoölogy of a century ago, lump together as "invertebrates," really comprises no fewer than fifteen of the great divisions of the animal kingdom, each of them equivalent as a system to all the vertebrates together. So there is, naturally, nothing whatever that can be predicated of "the embryos of invertebrates" beyond the not very illuminating fact that most of them do reproduce in some way. Most "invertebrates," like all mammals, have minute eggs with no yolk mass. Naturally, they do not "double round" what does not exist.

Nevertheless, certain "worms and other articulates," in particular, the insects, really do "lie doubled backward around the yolk"—unless one prefers to call it that the "articulates" double frontways, and that such vertebrates as double at all, bend the wrong way.

But who except a Fundamentalist has ever supposed that the vertebrates are descended from any insect? What point, then, in the way either doubles round its food supply?

Both the insects and the vertebrates are, indeed, supposed to be descendants of a common ancestor. But all evidence goes to show that this common ancestor was very much too primitive a creature to have provided his offspring with any sort of ample food supply. His embryos, if they had yolk masses, might puzzle "evolution". But they did not. So why bother?

Both vertebrates and insects, then, start from an ancestry with small eggs. The embryos themselves have evolved along with the adults. Both, quite independently, have evolved large eggs with abundant yolk. Why, then, should anybody but a Fundamentalist D.D. expect to have the two doubled round their food-supplies in the same way?

Funnymentals

"I believe what I was taught, and I don't think that I ought to think." Argument of a Fundamentalist refusing to subscribe.

"Evolution is a fraud. It is a blank unproved theory, unsupported in fact. It is illegal to teach it in tax supported schools. Under the common law it is blasphemy." Rev. L. S. Hoover, at Free Methodist Church, Ithaca, N. Y.

"The Christian Church must repudiate the most subtle and monstrous lie that the devil has ever thrown into the face of the Son of God, and drive the whole diabolic spawn of evolution into the nethermost depths of hell where it belongs, when finally the Angel of the Apocalypse puts the lid upon the pit and bottles up the whole pestiferous tribe, there to await the final judgment of an insulted God." Rev. Levi Bird, quoted by San Antonio Bible Institute.

Boners From Exams

Isostasy is the place where earthquakes come from.

The chief argument against the nebular hypothesis is that it would make the sun revolve around the earth every few minutes.

Food that is not used leaves the body as a foetus.

The law of recapitulation: Animals are recapitulated by immigration.

Mosaic vision was the vision Moses had in the wilderness.

Darwin was a very famous man because he discovered the science of relativity and wrote a book on it.

Cuvier made a careful study of all elephants extant, and proved that they were totally different from fossil shells.

Bricks and Bouquets

"I consider EVOLUTION a cheap, nasty little magazine, and one that would militate against frank and open discussion of any problem. I am most sorry that it is going to be revived. As for some of the names on your staff, I have watched them for years, trying to prove that they are an improvement on the ape, and I haven't found that they have established their cause." *William Procter.*

"I enjoyed the first number of the new series. If future numbers will carry the same message and adhere to a similar high standard, the journal is bound to succeed." *Wm. C. Darrah.*

"You are one of the best examples of perseverance I have ever met, and we need you to inspire us when skies are dark and faith is weak. May success crown your efforts." *Oswald Schlockow.*

"I recently received EVOLUTION—Got a glimpse of it only, when some thirsting soul also glimpsed it and put it in his pocket. He has good judgment, may it do him oodles of good." *W. T. DeCoster, M.D.*

"Congratulations on your resumption of the publication of EVOLUTION. Wish you all the success you deserve." *Theodore C. Abell.*

"Am glad you did not pussyfoot in naming the mag. Evolution is an established fact, and there is no use beating around the bush when speaking of it. Seems to me if you had more of the criticisms and carping allusions from ministers and others it would make more popular reading. Take a good healthy whack at them like Ingersoll used to do. Some of them can call names, but they can't really answer the evidence for evolution." *A. L. Faunce.*

"Please do me a favor and discontinue sending EVOLUTION. To my ethics it is very disgusting and anarchistic. Whoever had the audacity to send you my name must be some poor simple minded creature, whose weak mind was easily turned by the absolute rot and fairy tales contained in your magazine. Here's to your complete failure." *Mrs. John Borkosky.*

"I am very glad that you are again able to take up your fight against ignorance and superstition. Never was such a fight more necessary than now." *Harrington Johnston.*

"EVOLUTION should be placed in every school and library, as well as in the homes I sincerely hope for the success of your efforts in placing before the people the facts disclosed by research, and helping to break down the prejudice which is so prevalent." *Elza E. Hadley.*

POOR LITTLE MONKEY?

They tell me man from monkeys came,
With this I might agree.
But, Gosh all Friday, it's a shame,
Or seemeth so to me,
To class a monkey with a man.
Here I arise to say
It isn't fair, denounce the plan;
I just stand for 'fair play'.

What has a monkey ever done
To merit such abuse?
He lives as Nature's loving son;
Fashions no creeds obtuse;
He doesn't smoke, he doesn't chew,
Nor drink 'white mule' or beer,
And to his mate he's kind and true,
Nor rules his child with fear.

He doesn't work for any "boss",
Out in his forest, wild,
But shares his gains, likewise his loss,
With kindred undefiled.
He never built a "private" fence
Around his cocoa tree,
Nor put up signs "Keep off the Grass!".
In Nature he is free.

The monkey, far as I can see,
Has lived life as he should.
You say man *came from* monkey?—Bah!
That theory is no good.
At least—if it is really true,
Get ready, pack your sack,
For I am sure that I can show
We really should *GO BACK*.

Guy Lockwood.

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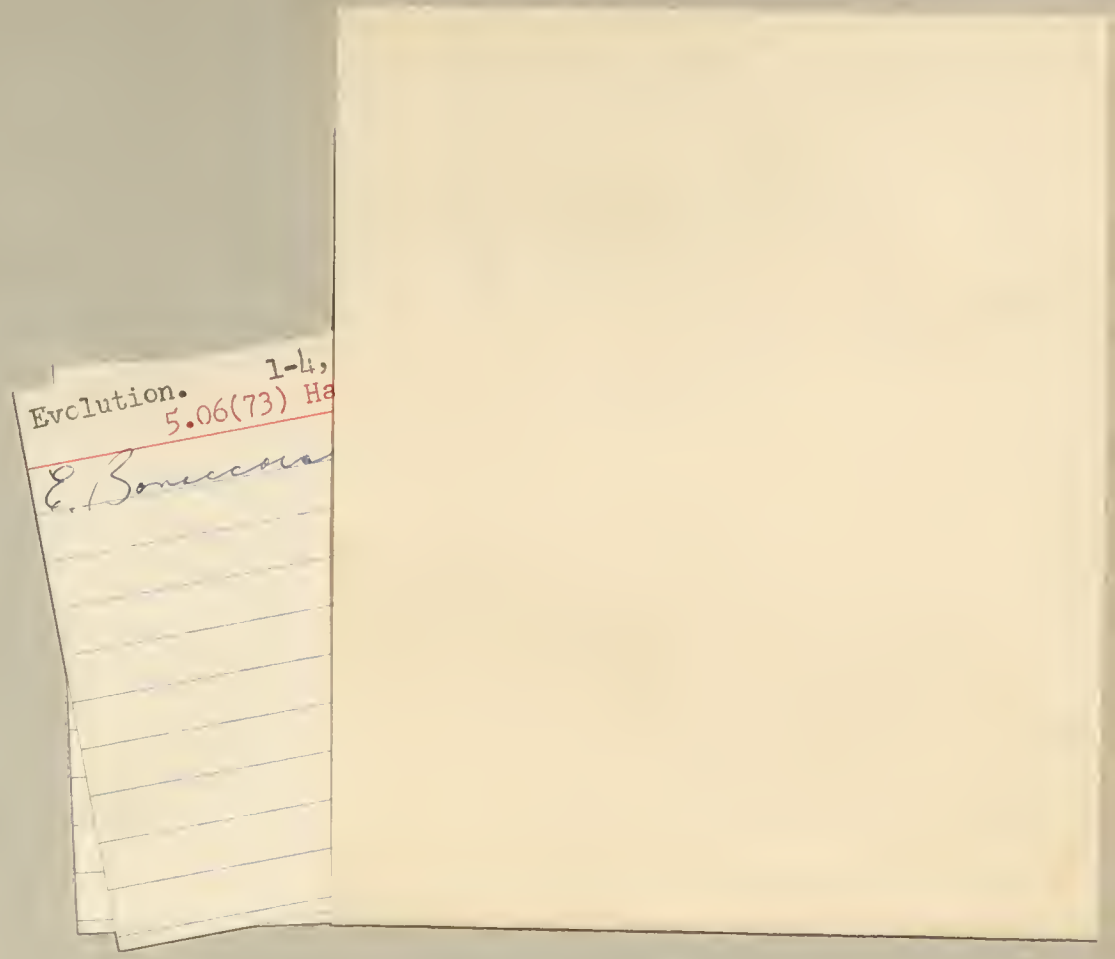

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